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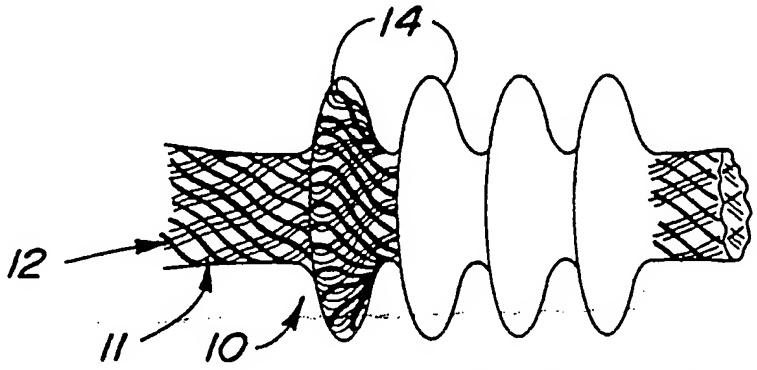
(54) Title: INTEGRALLY FLANGED FLEXIBLE SLEEVE

(57) Abstract

A braided sleeve (10) is comprised of a first material in monofilament form (11) characterised in that it has high modulus of elasticity and is capable of taking a resilient set. The first material is interbraided with a second material in filamentary form (12) which is chosen to impart a property to the sleeve according to its intended end use. The sleeve is further processed to introduce a series of resiliently set radially projecting according folds or pleats (14) which extend in a series lengthwise of the product and may be in groups with intervening spaces in which no corrugations are formed. The braid allows for radial expansion and contraction so that is resiliently conforms to the shape of an elongated substrate which may have irregularities in its cross section and further allows for appreciable axial elongation and expansion so as to protect a substrate having the property of axial extension and contraction.



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Integrally Flanged Flexible Sleeve

Field of the Invention

This invention relates to flexible sleeves and more particularly to braided sleeves formed of materials including resilient monofilaments and more particularly relates to sleeves incorporating both the properties of radial expandability and compression inherent in a braided structure along with extended axial elongation provided by corrugations or flanges integrally moulded into the sleeves.

Background of the Invention and the Prior Art

Substrates such as electrical wire or cable are frequently protected with braided sleeves formed of various materials, such as wire, for the purpose of providing electrical shielding or of abrasion resistant thermoplastic materials for the purpose of providing abrasion resistance. Other yarns and filamentary materials may be used in the braided structure for known purposes such as the protection of the substrates from the damaging effects of high temperatures. Thermally insulating yarns which may be treated with flame retardant or resistant coatings or filaments formed from plastics of the type known as aramids are conventionally employed for providing thermal protection.

A family of braided products of the type referred to is sold under the registered trademark EXPANDO by The Bentley-Harris Manufacturing Company. Abrasion resistant braided sleeves of this

type are disclosed in US Patent No 4,754,685. This patent discloses a braided tubular sleeve comprising a resilient monofilament material and an abrasion resistant monofilament material present in a ratio of from about one end of resilient material to two ends of abrasion resistant material up to about ten ends of resilient material to one end of abrasion resistant material. The resilient material comprises a polymeric material of the type commonly referred to as an engineered plastics. The resilient material has a tensile modulus of at least 100,000 psi and most preferably at least 1,000,000 psi and the abrasion resistant material comprises a polymeric material having a tensile modulus at least 50,000 psi less than the modulus of the resilient material. Braided sleeving so formed is well suited for field installation over wire and cable bundles or harnesses, hoses and the like because the sleeving has an open weave construction which enables the braided tube to expand to several times its original diameter when the braided tube is axially compressed. When the axial compression is released, the braided structure is biased to return to its original smaller diameter due to the resilient nature of the engineered plastics material from which it is braided. This property gives the braided sleeving the desirable characteristic of being self fitting and conforming to the substrate and to any irregularities which may be along the length of the substrate. Once the sleeving is installed on the substrate, it tends to remain relatively tightly conformed to the exterior of the substrate and it easily conforms to bending and flexing of the substrate, thus providing continual abrasion protection for the substrate.

Other products sold by The Bentley-Harris Manufacturing Company under the registered trademark EXPANDO include material introduced into the braided structure which are heat resistant and flame retardant monofilament or multifilament materials. Relatively bulky yarns may be integrated into the braided structure for the purpose of adding further thermal protection or for damping vibration-produced noise. A sleeve having bulky yarns for damping of vibrations is shown in US Patent No 4,989,422.

In certain applications, as for example, where the substrate itself is intended to have the capability of extended axial expansion, products of the type aforementioned do not have the capability of sufficient axial expansion to accommodate the need. Over time, particularly in robotics applications and similar applications as for example where a coiled cable must be allowed to expand or contract appreciably in the lengthwise direction and where the cable is to be used where it is exposed to high temperatures or to abrasion, the need has arisen for a product which will afford protection and allow for appreciable flexible extension and contraction of the substrate.

Summary and Objects of the Invention

The present invention provides a braided sleeve comprised of a first material in monofilament form, the first material having a high modulus of elasticity. Preferably, the first material is provided either as individual monofilaments or groups of one to about five monofilaments. The monofilaments are preferably formed of engineered plastics materials capable of taking a set, or may in certain instances be a resilient wire. Interbraided with the first filamentary material is a second filamentary material chosen to impart a property to the sleeve which is dependent upon the type of protection that the sleeve is intended to afford. The second material is formed optionally of monofilaments or of multifilaments or of combinations thereof, depending upon the desired properties of the sleeve. According to one embodiment of the invention, sleeves are provided wherein the second filamentary material is an abrasion resistant material. According to a second embodiment of the invention, the second material is a relatively bulky yarn provided for the purpose of affording thermal protection. The second material may be coated with fire retardant chemicals in order to provide protection against flammability. Further, the second material may be glass fibre, metal wire or an aramid fibre of the type sold under the trademarks NOMEX or KEVLAR. The present invention comprises a sleeve which is braided using material of the type aforesaid and further has a plurality of resiliently set, radially projecting

accordion folds or flanges incorporated into the braided structure which extend in a series lengthwise along the product, preferably in groups with intervening spaces formed therebetween.

For use in installation of sleeves of the present invention means such as collars or tape should preferably be provided for fastening the ends of the sleeve to the elongated, extendable substrate. For certain more limited applications, the first material may also possess the necessary protective properties, and in this case, the resilient material may be the same or substantially the same as the protection material.

The present invention further provides a method of making such a product which comprises forming a braided sleeve of first and second materials wherein the first material is a monofilament material having a high modulus of elasticity, and the second material imparts properties useful in providing protection to a substrate. Once the braided structure is formed, the bellows or accordion shape is formed into the product by sequentially resiliently setting individual bellows elements along the length of the sleeve. By resiliently setting, as the terms is used herein, reference is made to incorporation of a permanent set or a bias in the resilient filamentary material. Preferably, the resilient set is formed by compressing the sleeve-like material and applying heat thereto so that the product is permanently deformed in the compressed condition. Due to the resilient nature of the monofilament material, after the portion of the sleeve having the accordion folds is stretched out axially, it will spring back to the set condition once it is released. As is known in the art, resiliently set materials may assume a permanent set without the application of heat. For example, resilient metal wires may take a permanent set by compressing a sleeve including such materials so that the wires are deformed beyond their elastic limit. Thereafter, the wires always return to the permanently deformed conditions. Under certain conditions, it is known that certain plastics materials can be caused to take a permanent set through cold working and/or the use of solvents although usually the time required for the material to assume a

permanent set is so long that it is not envisioned as an economically feasible method of setting the materials.

A preferred monofilament material useful as the first yarn in forming sleeves according to the invention is a polyester monofilament yarn. A preferred abrasion resistant yarn is comprised of nylon. The braided sleeving provided by this invention can be formed on conventional circular braiders. The braid should not be formed so tightly as to inhibit the flexibility of the braided sleeve or the ability of the sleeve to radially expand when axially compressed. In general, it is preferred to have an open weave braid which provides maximum flexibility and maximum radial expansion, for example, up to three times in diameter to facilitate the ease of installation over various substrates, particularly irregular substrates, such as wire bundles. Such radial expansion is particularly useful to enable the installer to slide the sleeving over connectors at the end of wire or cable bundles or fittings on the end of hoses then allow the sleeving to extend axially and contract radially to conform snugly with the wire or cable bundle or hose.

The resilient engineered plastics yarn useful in this invention should have sufficient tensile modulus to provide the desired springback characteristic in the braided sleeving. Preferably, the fibre or yarn used is polyester but it will be appreciated that any of the family of plastics known as engineered plastics are suitable for use in the sleeves of this invention. By engineered plastics, it is meant that the plastic has a tensile modulus of greater than 100,000 psi and preferably greater than 150,000 psi and more preferably at least 200,000 psi. Examples of engineered plastics are the olefin polymers of which some preferred olefin polymers are high density polyethylene, polypropylene, polybutene-1, ploy 4-methyl pentene and fluorinated polyolefins such as ethylenetrifluorochloroethylene copolymers, ethylenetetrafluorethylene copolymers and vinylidene fluoride polymers, especially polyvinylidene fluoride and blends thereof, for example, the fluorinated olefin blends as described in British Patent No 1,120,131; polyesters, for example, polyethylene terephthalate, polytetramethylene terephathalate,

for example, those treated as described in US Patent Nos 3,968,015, 4,073,830 and 4,113,594; polyphenylene-oxide and -sulphide, blends of polyethylene-oxide with polystyrene, silicone-carbonate block copolymers, polyketones, such as polyarylether ketones, for example, those described in US Patent Nos 3,751,398, 3,914,298, 3,953,400, 3,965,146, 4,024,314, 4,111,908 and 4,229,564; polysulphones, for example, polyaryl sulphones, polyarylether sulphones, polyetherimides, for example, those described in US Patent No 3,847,867; polycarbonates, especially those derived from bis phenol-A, polyamides, especially those described in US Patent Nos 3,551,200 and 3,577,931; epoxy resins and blends of one or more of the above-mentioned polymeric materials either with each other or with other polymeric materials. Additional discussion of such materials is found in British specification No 1,529,351. The disclosures of the above patents and specifications are incorporated herein by reference.

Brief Description of the Drawings

Figure 1 shows a braided sleeve according to the present invention;

Figure 2 shows a cross-sectional schematic view of the invention as it is utilised to protect an elongatable cable of the type utilised for connection of a telephone receiver to the base of the instrument; and

Figure 3A-3D are schematic views illustrating the method of making sleeving formed according to the invention.

Detailed Description of the Invention

The braided sleeving of the invention, as illustrated in Figure 1, comprises a sleeve 10 formed of a first filamentary material 11 made of a resilient material in monofilament form, which material is resiliently settable and is preferably a high modulus, engineered plastics material such as polyester, although resilient wire may be employed. Interbraided with the first

material is a second material 12 formed of a material having specific protective properties for a substrate such as flame resistance, thermal resistance or abrasion resistance. Suitable materials useful as the second material include nylon, metallic wire, aramid fibres, glass fibres and the like. The second material may be provided in either monofilament or multifilament form depending upon intended the end use of the sleeve. The second material may be either a coated or uncoated bulky yarn as desired for the specific properties which are to be imparted to the product, as illustrated in Figure 1. The bulky yarn may have a denier of between about 100 and 7,000.

Preferably, the sleeve is not braided so tightly so as to inhibit its ability to radially expand when axially compressed. In general, it is preferred that there be a relatively open braid with no matrix materials filling the spaces between filaments to provide for maximum flexibility and radial expansion. The braided sleeving of the kind provided in this invention is adapted to be formed on conventional circular braiders. As an example, resilient monofilaments may be fed off one bobbin and monofilaments or yarns having a desired protective property fed off the next bobbin or if desired, both may be combined and fed off each bobbin.

As shown in Figures 1 and 2, the braided sleeve is provided with radially extending bellows or corrugations, 14. The corrugations 14 may be provided in series of two or more, a series or group of four such corrugations being shown in Figure 2, each series being separated by an uncorrugated portion. Alternatively, the entire length of sleeve may be formed with corrugations.

As can be seen in Figure 2, a sleeve formed in accordance with the invention is fitted over an elongated, helically coiled cable, generally indicated by 15. As is shown in Figure 2, suitable clamping means such as pressed metal clamps 16 secure each end of the sleeve to the cable 15.

In forming the corrugations as illustrated in Figures 3A-3D, an uncorrugated sleeve is mounted on a mandrel 17 and secured at one

end thereto by a stop means, generally indicated by 18. The sleeve material is then gripped by a clamping means 19 and pressed axially against the stop 18 to form a radially extending flange. Thereafter, a second section of sleeve is gripped by the clamping means at a point displaced from the first flange and pressed towards the first flange. This process is repeated until a group of flanges or corrugations is formed, after which, heat, preferably from radiant heater 20 is applied to the series of corrugations, as shown in Figure 3B, to raise the temperatures of the resiliently settable material to a point above the softening point. Thereafter, the series of corrugations is cooled by a supply of cooling air from an air blower 21 (Figure 3C) resulting in the inducement of a permanent set to the group of corrugations. In the form of the invention shown in Figure 2, the stop means 18 is then displaced axially, as shown in Figure 3D, to a point allowing for production of a second group of corrugations. The gripping means 19 is then employed to form each of the corrugations of the second group, and the application of heat and cooling air is then repeated.

The following examples illustrate present preferred produces made according to the invention.

Example 1

A thermally resistant sleeve formed according to the invention was manufactured on a circular braider from 10 mil diameter polyester monofilament manufactured by Johnson Filament of Williston, Vermont as the resilient filamentary material and an aramid yarn of 400 denier sold under the trademark KEVLAR by E I DuPont as the secondary filamentary material. The braider had 72 carriers, 50% of which were loaded with three ends of the monofilament polyester and the remaining carriers loaded with aramid yarn. The monofilament polyester had a modulus of elasticity of 2×10^6 psi. The resilient polyester monofilament had a softening point of about 400°F. The sleeve off the braider had an inside diameter of 1.0 inches and was placed on a mandrel having an outer diameter approximately equal to the sleeve inside diameter with one end of the sleeve affixed thereto by a clamping

ring. Four accordion flanges or folds were formed sequentially by first gripping a section of the sleeve with a second ring at a location spaced approximately 1.0 inches from the first ring and pressing the sleeve material against the first ring. This process was repeated by sequentially holding the gathered material in position at a distance and pressing the next section against the first until four accordion folds were formed. These were then heat set by application of heat from an air gun for a period of about 1 minute to raise the temperature to about 400°. Cooling air was then supplied to set the corrugations in a resilient biased condition. The sleeve produced in this Example has four corrugations in each of four groups with approximately 0.4 inches between each group. The sleeve material prior to the formation of the corrugations had a length of 17 inches. After corrugation, the length was approximately 11 inches. The sleeve was capable of extension to its original length and returned to the biased condition when its ends were released.

Example 2

An abrasion resistant sleeve was made according to Example 1, except that the aramid yarn was replaced with nylon monofilament having a diameter which was preferably larger than the diameter of the resilient yarn. Monofilament nylon available under the trademark PRESLYN from Johnson Filament of Willison, Vermont was employed. This material is available in 15 mil diameter and when braided in a ratio of two ends of polyester and one end of nylon on each of 48 carriers on a circular braider produces a sleeve having excellent abrasion resistant and springback characteristics. The softening temperature of the nylon monofilament is 350°F, whereas the softening point of the polyester is 400°F.

The ratio of filamentary materials having resilient properties and those having properties which provide protection to the substrate can be determined after a few field trials. In addition, it will be appreciated that filamentary materials providing substrate protection may be combinations of materials

having different properties. For example, combinations of filaments of metal and strands or yarns of mineral materials such as glass or other combinations including natural and synthetically made filaments may be utilised.

CLAIMS

1. An oversleeve for elongated, axially expandable substrates, said oversleeve comprising a resiliently settable, resilient monofilament material;

the oversleeve being a braided structure;

the resilient monofilament material being uniformly distributed throughout the braid; characterised in that

the sleeve has plural regions which are individually, axially compressed to form a plurality of radially expanded, axially spaced corrugations, the resilient monofilaments in the corrugations being resiliently set to resiliently restrain the sleeve in the corrugated configuration;

the cross over points of the braid being relatively free to permit relative movement of the braided structure, thereby allowing for radial expansion and compression of the sleeve relative to the substrate; and

the corrugations being resiliently expandable to allow for axially elongation and compression of the sleeve in accordance with axial elongations and compressions of the substrate.

2. An oversleeve according to claim 1, further including securement means disposed at each end of the sleeve for securing the sleeve ends to adjacent surfaces of the substrate.

3. An oversleeve according to claim 2 wherein said securement means comprises a heat settable tape.

4. An oversleeve according to any preceding claim wherein said first material is a heat settable material.

5. An oversleeve according to claim 4 wherein said first material has a tensile modulus greater than about 2,000,000 psi.

6. An oversleeve according to claim 5 wherein said first material comprises a polyester.

7. An oversleeve according to claim any of claims 4-6 wherein said second material has a softening point higher than said first material.

8. An oversleeve according to claim 7 wherein said second material comprises an abrasion resistant monofilament material.

9. An oversleeve according to claim 7 wherein said second material comprises bulky yarn.

10. An oversleeve according to claim 9 wherein said second material comprises an aramid yarn.

11. An oversleeve according to claim 10 wherein said second material has a denier of between 100 and 7,000.

12. An oversleeve according to claim 11 further including means for securing the sleeve at each end to an elongated substrate threaded through said sleeve.

13. A method of making a textile sleeve for the bundling of elongated substrates comprising:

braiding the sleeve on a circular braider using at least one filamentary material comprised of resiliently settable monofilament;

positioning the braided sleeve on a mandrel;

clamping a portion of the sleeve to the mandrel;

forming accordion pleats in the sleeve by sequentially displacing adjacent sections of the sleeve material toward the clamped portion until a series of pleats are formed; and

applying heat to each pleat to heat the resiliently settable material to a temperature above the softening point and then cooling the pleat to induce a permanent set to the resiliently settable material.

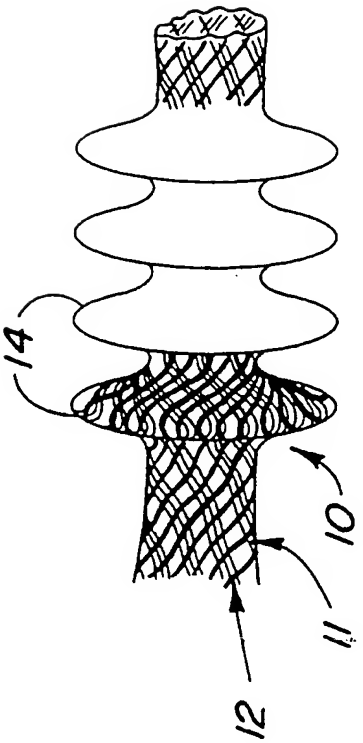

FIG. 1

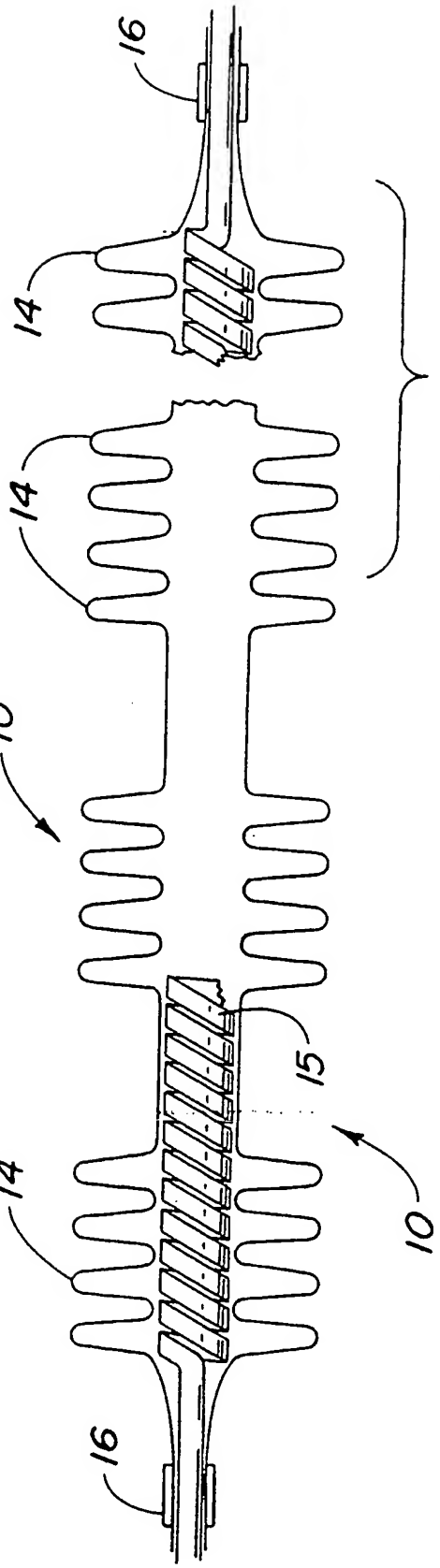

FIG. 2

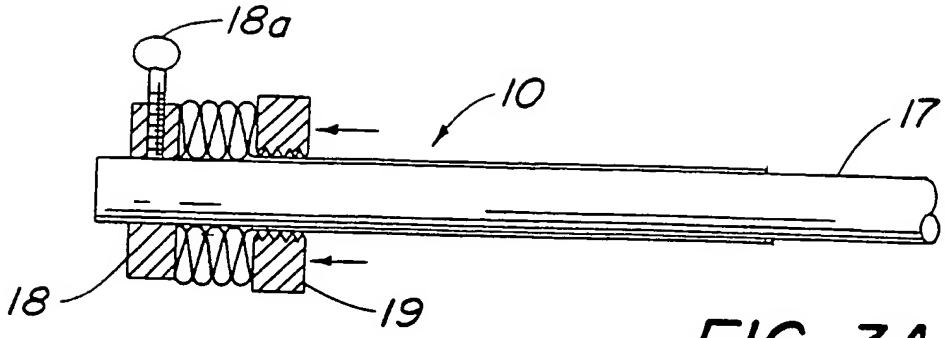

FIG. 3A

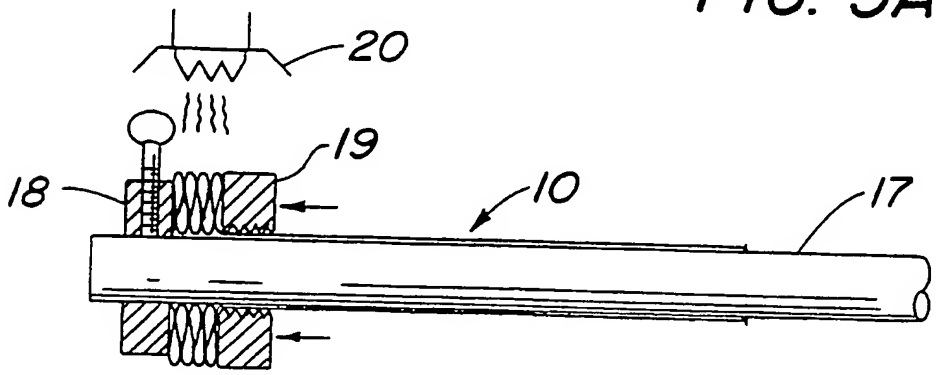

FIG. 3B

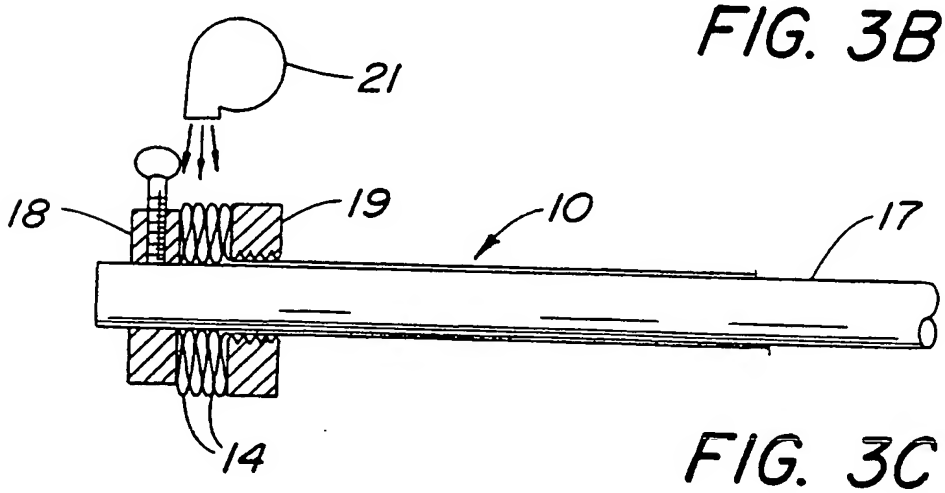

FIG. 3C

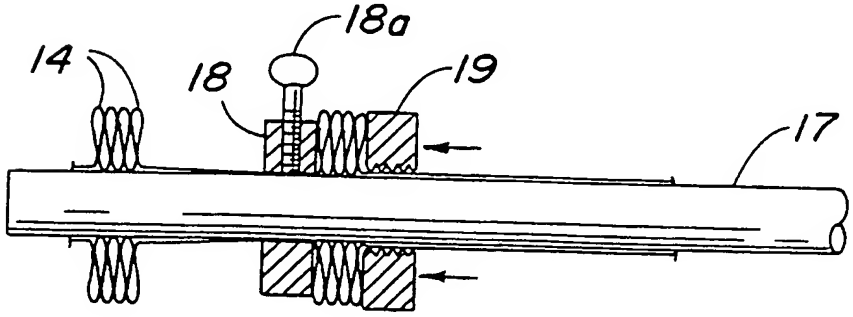

FIG. 3D

INTERNATIONAL SEARCH REPORT

Inten. ıal Application No
PCT/GB 93/02317

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16L11/11 F16L11/118 H02G3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16L H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,2 596 490 (COMPAGNIE DES PRODUITS INDUSTRIELS DE L`OUEST) 2 October 1987 see abstract; figures 1-5	1
A	FR,A,2 533 996 (CAOUTCHOUC MANUFACTURE ET PLASTIQUES) 6 April 1984 see abstract; figures 1-5	1
A	GB,A,1 175 042 (COMPOFLEX COMPANY LTD) 23 December 1969 see column 1, line 9-21	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 January 1994	18. 02. 94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Angius, P

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INTERNATIONAL SEARCH REPORT

Inten. nal Application No
PCT/GB 93/02317

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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FR-A-2533996	06-04-84	NONE		
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